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Quantum Capacitance for Quantum Computation C.M. WILSON, T. DUTY, F. PERSSON, M. SANDBERG, G. JOHANSSON, L. TORNBERG, J. BYLANDER, P. DELSING, Chalmers University — We present measurements of superconducting quantum bit (qubit) circuits utilizing the quantum capacitance (QC) of a single cooper-pair box (SCB). The QC is essentially the curvature of the SCB energy bands near the charge degeneracy point, and has recently been measured by our group and others. The curvature arises from the avoided level crossing induced by the Josephson coupling of the SCB. The QC can be much larger than the geometric capacitance, and changes sign between the ground and excited states. We present a qubit with integrated readout that embeds a SCB in a resonant circuit and detects changes in the QC as changes in the phase of a reflected microwave signal. We have calculated that this readout method is strictly quantum limited independent of the quality factor (Q) of the the resonator. This allows great flexibility in the design and optimization of the readout. Calculations show that the method should be able to achieve single-shot discrimination of the qubit state under realistic experimental conditions. We also present preliminary measurements of coupled qubit circuits, with both fixed coupling and a variable coupling scheme based on the ground-state QC.

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